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September 14, 1993

Solid Mechanics Program (1132SM)
Department of the Navy
Office of the Chief of Naval Research
Arlington, Virginia 22217-5000

Final Report for N00014-87-J-1193
Several Fundamental Issues in the Mechanics of Inelastic Behavior

Attn: Dr. R.S. Barsoum

Dear Roshdy:

This is a final report and note of thanks to you and ONR for the support of research that began in 1987 and continued through to 1993 with a three year no additional cost extension.

As you know, I was the Honorary Chair of the International Symposium on Plasticity and its Current Applications to be held in Baltimore July 19-23 and presented two papers that summarized two lines of my individual endeavor under ONR sponsorship. One was an extension of my earlier published work (Lee Anniversary Volume) on the microstructural features that control the flow strength of ductile metals and alloys. The other was an explanation of why, in a useful constitutive relation, it is necessary to define a plastic strain rate or increment that is not the rate of change or increment of whatever quantity may appeal to an author as an appropriate measure of finite plastic strain. Such a definition mirrors the accepted and necessary usage in fluid mechanics of the rate of deformation, a quantity which does not integrate over time to the finite deformation of the fluid.

Earlier at the International Congress of Theoretical and Applied Mechanics held in Haifa in August 1992 I presented a paper "Exploring Instability Resulting from a Non-Associated Flow Rule" that was then an up-to-date summary of what Ming Li and I have learned about that genuine but limited instability of configuration of a non-associated flow rule model for which the elastic response does not stabilize the plastic.

Additional papers will be forthcoming based on Dr. Li's thesis which represent several new directions plus a considerable advance over our joint Acta Mechanica paper "Non-Associated Plastic Deformation and Genuine Instability" in Acta Mechanica [Suppl] 3: 1992 and "Triaxial Test Instability of a Non-Associated Flow Rule Model" that appeared in this June's issue of the Journal of Engineering Mechanics, ASCE.

A list of publications from June 1987 to the present is given below. Those resulting from ONR sponsorship contain the appropriate acknowledgement to ONR and are shown with an asterisk.

Publications:

"On Past Developments, Current Activities and Future Directions in Plasticity," Res Mechanica, Vol. 21, 1987, pp. 393-400.

"Fundamental Research into the Man-made World," Mechanical Engineering, ASME, Vol. 109, 1987, pp. 56-60 (a staff shortened, rewritten and retitled version of my 1986 Thurston Lecture, "Alternate Modes and Future Directions of Fundamental Engineering Research")

"On Foreign Engineers in Academe," Foreign and Foreign-Born Engineers in the United States, National Academy Press, 1988, pp. 127-145.

"Comments on the Modelling of the Behavior of Sand" Constitutive Equations for Granular Non-Cohesive Soils Eds. A. Saada and G. Bianchini, Balkema, Rotterdam/Brookfield 1988, pp. 695-697.

"Conventional and Unconventional Plastic Response and Representation," Applied Mechanics Reviews, Vol. 41, 1988, pp. 151-167.

*"Stability Postulates in Plasticity" Developments in Theoretical and Applied Mechanics v.15, Eds. S.V.Hanagud, M.P. Kamat, and C.E.Ueng, Georgia Institute of Technology, 1990, pp. 862-869 .

"Past and Possible Future Directions in Plasticity" in Plasticity and Failure Behavior of Solids, Rabotnov Memorial Volume, eds. G.C. Sih, A.J. Ishlinsky, and S.T. Mileiko, Kluwer Academic Publishers, Dordrecht/Boston/London 1990, pp. 1-17 .

*"Average Flow Stress, Dislocation Motion Impediments, Cell Walls, Atomically Disordered Regions" in Topics in Plasticity, Anniversary Volume in Honor of Professor E.H. Lee, ed. Wei H. Yang, AM Press, Ann Arbor, 1991, pp. 72-82 .

"Industry, Competitiveness, and the National Attitude Toward Engineering" Engineering Education, vol. 81, no. 5, 1991, pp. 478-481 .

*"Constitutive Relations for Solids - Retrospect and Prospect" in Constitutive Laws for Engineering Materials, eds. C.S. Desai, E. Krempl, G. Frantziskonis, and H. Saadatmanesh, ASME Press, New York, 1991, pp. 3-12 .

*"Non-Associated Plastic Deformation and Genuine Instability" (with Ming Li) Acta Mechanica [Suppl] 3: 1992, pp. 161-171 .

*"Triaxial Test Instability Of A Nonassociated Flow Rule Model" (with Ming Li) Journal of the Engineering Mechanics Division ASCE, June 1993, pp. 1188 - 1204 .

Recent presentations of ONR sponsored research results in addition to those at the July 1993 International Symposium on Plasticity and the 1992 International Congress include:

Keynote Lecture at the October 1992 U.S.-Canada Workshop on "Recent Accomplishments and Future Trends in Geomechanics in the 21st Century"
Winter Annual Meeting of ASME November 1991 at a session in honor of the 65th birthday of Bruno Boley
The main invited lecture at the Third International Conference on Constitutive Laws for Engineering Materials, January 1991
U.S.National Congress of Applied Mechanics, May 1990 .
SECTAM March 1990

Among the honors received during the period of the grant:

National Medal of Science 1988
ASME Medal 1992
Honorary Doctor of Science, University of Illinois at Urbana-Champaign 1992
ASEE Hall of Fame 1993
Honorary Chair of the International Symposium on Plasticity and its Current Applications held in Baltimore July 19-23, 1993
The program of the Third International Conference on Constitutive Laws for Engineering Materials, 7-11 January 1991 carried the following statement "This Conference honors Professor D. C. Drucker for his significant and substantial contributions to the fields of this conference. He will present the Main Invited Lecture, and there will be a special program for his honor during the banquet on 9 January 1991".
Named distinguished Lecturer, ASME, 1987, 1988, 1989.

Other activities include:

Member:

National Science Board 1988-1994.
General Assembly of the International Union Theoretical and Applied Mechanics (Vice-President 1984-1988, President 1980-84).
Quarterly of Applied Mathematics, Mechanicca, Acta Mechanica Sinica editorial boards
U.S. National Committee on Theoretical and Applied Mechanics (Ch. 1966-68).
Engineering Advisory Councils of the FAMU-FSU College of Engineering, FAU College of Engineering
Also was a member of Council of AAAS, its Committee on Council Affairs, and the AAAS ad hoc Committee on Governance, a member of the Membership Committee of the American Academy of Arts and Sciences and a member of the Electoral Committee, International Union of Theoretical and Applied Mechanics .
President (1990-91) of the University of Florida Chapter of the honor society Phi Kappa Phi.

All best wishes.

Sincerely,

Daniel C. Drucker
Graduate Research Professor